SECOND REPORT

**National Steering Committee for**
**Application of Pesticides -**
**Western Defoliators**

April 17, 1990

USDA Forest Service
Washington Office/Forest Pest Management
2121 C 2nd Street
Davis, CA 95616
(916)758-4600
FTS 460-1715

CONTENTS

APPENDIX

A. Operating Guidelines for National Steering Committee

B. Committee Member Reports

C. Guidelines for Design of Field Experiments and Pilot Projects

# I. INTRODUCTION

The second meeting of the National Steering Committee for Aerial Application of Pesticides - Western Defoliators met in Albuquerque, New Mexico, October 11-12, 1989.

## A. Committee Members

| | |
|---|---|
| Roy Beckwith[2.] | PNW/FIDR (Corvallis, OR) |
| Jesus Cota | WO/FP (Washington, D.C.) |
| John Cunningham[1.] | Forest Pest Management Institute (Sault Ste. Marie, Ontario) |
| Gary Daterman[1.] | PNW/FIDR (Corvallis, OR) |
| Bob Ekblad[2.] | WO/ENGR/MTDC (Missoula, MT) |
| Kees van Frankenhuyzen[1.] | Forest Pest Management Institute (Sault Ste. Marie, Ontario) |
| Jim Hadfield[2.] | R-6(RO)FPM (Portland, OR) |
| Dennis Hamel[1.] | WO/FPM (Washington, D.C.) |
| Dave Leatherman[1.] | Colorado State Forest Service (Ft. Collins, CO) |
| Ladd Livingston | Idaho Department of Lands (Coeur D'Alene, ID) |
| John Neisess | R-5(RO)FPM (San Francisco, CA) |
| Max Ollieu | WO/FPM (Washington, D.C.) |
| Iral Ragenovich | R-6(RO)FPM (Portland, OR) |
| Pat Shea | PSW/FIDR (Davis, CA) |
| Larry Stipe | R-1(RO)TM (Missoula, MT) |
| Julie Weatherby | R-4(BFO)FPM (Boise, ID) |
| Jack Barry | WO/FPM Committee Chair (Davis, CA) |

---

1. Absent
2. Ad hoc participants

B. Purpose of Committee

The purpose of the committee is to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperator's ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

C. Agenda

Introduction
Review of 1988 Committee Recommendations & Accomplishments
Individual Project Reports and Discussions
Guidelines
Bibliography
Recommendations
Conclusions

D. Operating Guidelines for National Steering Committees (See Appendix A)

E. Committee member reports (See Appendix B).

F. The current draft of guidelines for designing field experiments and pilot projects are enclosed (See Appendix C).

## II. RECOMMENDATIONS

Recommendations are listed in order of priority followed by the organization that should initiate action.

A. Laboratory

1. **Pursue laboratory testing of new B.t. strains.**

   New strains of B.t. that may have significantly higher efficacy against western defoliators should be tested in the laboratory as they become available.

   PNW

2. **Develop a plan to obtain data on impact of pesticides on non-target leptidoptera.**

   There is need for data on the impact of pesticides on non-target leptidoptera. There is only limited information in this area and the committee recommends that a plan be developed by PSW/PNW to

obtain this data. The plan would include field inventory, laboratory evaluations, field testing, and methods to fund and accomplish this work.

PSW/PNW

3. **Develop, identify, and evaluate improved carriers for TM-Biocontrol.**

   The molasses carrier for TM-Biocontrol is a difficult to mix and apply in the field. There is need to investigate carriers that have been used for other biologicals and/or to develop new carriers. The committee recommends that PNW pursue this and evaluate carriers that show promise in the laboratory.

   PNW

4. **Explore techniques for rapid bio-assay of microbials.**

   There is need to determine the potency of microbial tank mixes immediately before spray operations. Bruce Hammock, University of California (Davis) Entomology Department may have developed an enzyme link immunosorbant assay (ELISA) method of determining potency. Pat Shea volunteered to explore the status and applicability of this technique and report to the committee.

   PSW

5. **Determine evaporation rates and physical properties of microbial tank mixes.**

   Data on evaporation rates and physical properties are needed for operational use of new microbial tank mixes and for input to the AGDISP and FSCBG aerial spray models. WO-FPM (Davis) jointly should explore ways to obtain this information.

   WO/FPM

6. **Obtain spread-factors for all microbial tank mixes.**

   Spread factors are essential to quantify the deposition (drop size and volume deposited) of aerial sprays. Without representative spread factors we cannot compare formulations, improve atomization, or quantify the quality of application including spray drift. WO-FPM (Davis) should pursue this task.

   WO/FPM

B. Field Tests

1. **Conduct field tests of new strains of Bacillus thuringiensis (B.t.) against western spruce budworm as recommended by PNW (Project 4502).**

   The committee places a high priority on field testing microbials that have demonstrated significantly improved efficacy in the laboratory. We must be cautious, however, and have some level of confidence that the producer will be available to provide a registration and product for operational use.

   PNW

2. **Conduct field tests of improved tank mixes of TM-Biocontrol.**

   This is high priority and the committee recognizes that before field tests are conducted improved tank mixes will need to be developed.

   PNW

3. **Conduct mating disruption tests using pheromones against western spruce budworm and Douglas-fir tussock moth (DFTM) outbreaks.**

   Preliminary tests against western spruce budworm were done on a small scale in 1980. These tests showed promise. Tests are needed to evaluate mating disruption strategy on large size (1000A) blocks for western spruce budworm to minimize the confounding influence of mated females flying into treatment areas. DFTM mating disruption would be tested on a pilot scale but on smaller-sized plots (less than 500 acres are acceptable). The committee recognizes that qualifying populations of DFTM will be difficult to predict.

   PNW

4. **Conduct field experiments of Sandoz Crop Protection Corporation (Sandoz) product SAN 415 SC 32LV (NRD-12 strain, 32 BIU per gallon) against DFTM to obtain efficacy data.**

   SAN 415 is registered for spruce budworm and gypsy moth but not for DFTM in California. It is formulated identically to Thuricide 32LV except it contains the NRD-12 strain instead of the HD-1 strain. SAN 415 has not been adequately field tested Against the douglas-fir tussock moth; therefore, the committee recommends field testing of SAN 415 against This species when adequate populations are found. Sandoz prefers to provide SAN 415 for forestry over Thuricide 32LV and Thuricide 48LV, the former an NRD-12 strain, the latter two HD-1 strains. The main production product at the Sandoz, Wasco, CA facility is Javelin,

an NRD-12 strain, for the agriculture market. It would be relatively easy for Sandoz to produce SAN 415 as it contains the same strain as Javelin. Last year the committee discussed testing Javelin and decided against testing as it is not formulated nor registered for forestry. Testing of SAN 415 is consistent with the committee's operating guidelines of encouraging the private sector to develop and maintain forestry-use pesticides. The intent is to maintain more labels to encourage competition.

PNW

5. **Conduct field experiments of lower doses of TM-Biocontrol.**

   Laboratory results suggest that lower dosages DFTM virus may be effective and this needs to be evaluated in the field to determine the lower effective threshold. The committee feels that emphasis should be placed upon reducing costs through reducing dosages.

   PNW

6. **Conduct cooperative field tests of several dosages (0.5, 1, and 2 ounces per acre) of Dimilin against DFTM in California.**

   There is need to identify the lower effective dose range of Dimilin (diflubenzuron) against DFTM for economic and environmental reasons. The need to conduct tests in California parallels the need discussed in paragraph 4 above.

   PSW

C. Pilot Projects and Cooperative Field Tests/Pilot Projects

1. **Conduct cooperative pilot test of the Sandoz B.t. product SAN 415 against western spruce budworm.**

   Recommendation is subject to review by the committee of NRD-12 strain performance data and to Sandoz' intent to market SAN 415 for forestry use. If data are supportive, the committee may recommend operational use in lieu of pilot testing.

   PNW

2. **Conduct cooperative pilot test of TM-Biocontrol, double (spring and summer treatments) against new, low level, and sub-outbreaks of DFTM.**

   There are data that suggests a double treatment strategy using TM-Biocontrol might control early emerging infestations of Douglas-fir tussock moth. Such a strategy has significant potential for major cost/benefits.

   PNW

3. **Conduct pilot test of B.t. against new and low level outbreaks DFTM.**

   The above comments (III,C,2) apply.

   PNW

4. **Conduct pilot test of Dipel 8L and Dipel 8AF applied at 32 ounces per acre to control western spruce budworm.**

   The committee suggests that Abbott Laboratory conduct a pilot test to evaluate on an operational scale effectiveness of Dipel 8L and Dipel 8AF applied at ultra low volumes of 32 ounces per acre. The FS would be a cooperator with Abbott Laboratory bearing the major expense.

   Abbott Laboratories

D. Equipment, Models, and Technology Development

1. **Conduct airport spray trials to characterize Dipel 6AF.**

   R-6 is considering operational use of Dipel 6AF, however, we lack information on field handling, atomization, spray deposition, and swath widths for the improved formulation. The committee recommends that WO-FPM (Davis), in cooperation with Abbott Laboratory and R-6, conduct spray trials at Davis, CA to characterize Dipel 6AF.

   WO/FPM

2. **Evaluate and recommend methods of sampling ultra low volume (ULV) sprays on pilot and operational projects.**

   Monitoring spray deposit is an essential element on spray projects. Monitoring assesses the on and off target deposition and helps to determine if an adequate amount of spray reached the target. ULV sprays, which are applied in small drops, are difficult to detect due to visibility and tendency to deposit on objects smaller than traditional samplers. An inexpensive, rapid, and easy to use method is needed for use on pilot and operational projects.

   MTDC

3. **Evaluate existing aircraft guidance systems and provide recommendations for operational deployment.**

   The FS has experienced field problems with the Pathlink aircraft guidance and tracking system. The committee recommends that there be no further use of Pathlink until an engineering evaluation is made to determine its capabilities and limitations, and its relationship to GPS and GIS; and that MTDC be requested

to do this work. WO-FPM will send a letter to Director, Engineering requesting an engineering evaluation of Pathlink and investigate if other systems exist.

MTDC

4. **Evaluate the utility of the computer model Computer Assisted Spray Productivity Routine (CASPR) on a pilot or operational project.**

CASPR is a model that calculates the productivity of spray aircraft. Input variables include aircraft speed, turn times, load capacity, swath widths, etc. The model has potential to reduce application costs through more knowledge and better estimates during negotiated contracts, and selecting optimum types of aircraft for projects. The committee recommends that CASPR be evaluated to assess its precision on a pilot in planning an operational project with MTDC taking the lead.

MTDC

5. **Update reference reports on atomization of current pesticide tank mixes.**

WO-FPM (Davis) has sponsored numerous wind tunnel tests at University of California, Davis Campus, to characterize the number and size of drops that are atomized from a variety of nozzles. Variables included tank mix, flow rate, atomizer, atomizer orientation, and air speed. Atomization data are used to select the proper spray parameters to support effective treatment. Data are scattered in several reports and are needed for several new tank mixes. Such data should be gathered and bound in one or two references. Further, an inventory should be taken to identify those tank mixes which need to be checked for atomization. Concurrent with wind tunnel tests is the need to determine physical properties of the tank mix.

WO/FPM

6. **Update and add spray nozzle specification data to the Program WIND aerial application equipment handbook.**

This Program WIND publication is being used nationally by Federal and State agencies. The committee recommends that the reference be enhanced with the addition of spray nozzle specifications. MTDC should include this when the handbook is revised.

MTDC

7. **Coordinate complex terrain modeling with Global Positioning System (GPS), GIS, and expert system activities being developed by the FS.**

WO-FPM (Davis) and MTDC are pursuing the identification and incorporation of a suitable complex terrain code in the FSCBG model. A meeting is scheduled at WO-FPM, MAG during December, 1989 to discuss coordination and cooperation. The committee encourages close coordination with the FPM Advanced Technology Task Force and WO-CS&T.

MTDC

8. **Determine physical properties and drag coefficients of substances.**

The FS has need to aerially apply solid forms of pesticides, pheromones, seeds, and fertilizers. To predict distribution of these substances it is important to know the drag coefficients and physical properties of the particles. As substances are being considered for field use, MTDC should be contacted for these physical measurements.

MTDC

E. Information Management

1. **Plan and conduct multi-year monitoring, analyses, and data management of spray treatments.**

Even short term benefits of treatment cannot be determined during the first year of treatment. For cost/benefit information and other economic analysis, the benefits or lack of benefits over 3 to 5 year periods should be established and recorded. This includes the R-6 Meacham Pilot Project conducted in 1988. Monitoring during 1989 shows that the benefits of treatment were carried over from 1988 to 1989. Monitoring the R-3 Jemez Mountain control project showed that the western spruce budworm was kept suppressed for 5 years. This is valuable information in developing control strategies and in calculating cost/benefits for future control operations.

WO/FPM

2. **Publish a reference and maintain a Data General computer data base on western defoliator aerial spray projects.**

Julie Weatherby has prepared an outline for collecting and indexing basic data on aerial spray projects. The committee recommends that data be collected from projects dating back to 1970, be indexed, and added to the FS's national data base, searchable by index number, and also that it be published. The committee will send a letter to Regions 1, 2, 3, 4, 5, 6, and 10 and PSW, PNW, INT, and RM requesting their cooperation in providing references and/or base data. The committee members volunteered to assist in this endeavor. WO-FPM (Davis) will take the lead with a draft report ready by August 1990.

WO/FPM

F. Administrative

1. **Committee Operating Guidelines.**

   a. Emphasize cooperation between FIDR and FPM especially in planning and conducting field projects.

   b. Continue to emphasize the need to field test new strains of B.t. and not the HD-1 strain. The HD-1 strain has been adequately tested by FIDR, however, unique or unusual changes to HD-1 or its carrier may qualify it for testing.

   c. Maintain the traditional approach to field testing and pilot projects.

   d. Maintain this Steering Committee.

   e. Encourage thorough and timely reporting of field tests and pilot project results.

   f. Facilitate cooperation with industry and encourage development and testing of microbials.

   g. Seek ways to reduce costs of field tests and pilot projects, and to encourage industry to share costs.

2. **Guidelines for Field Tests and Pilot Projects.**

   a. Drafts of the Field Test and Pilot Project guidelines have been submitted to WO and are available for review by State cooperators and industry. FIDR has not yet decided whether to incorporate the Field Test guidelines in the FS handbook. FPM will incorporate the latest version of the Pilot Project guidelines in the FS handbook when the handbook is ready for publication. Both guidelines will continue as drafts for the foreseeable future.

   b. Need for other guidelines was discussed and the committee suggests that guidelines be written for conduct of airport spray characterization trials.

3. **Environmental Impact Statement for DFTM.**

   The committee recommends that a west-wide programmatic EIS be prepared for DFTM management.

4. **NOVO's Foray 48B, Bacillus thuringiensis.**

   The committee encourages NOVO to pursue a pilot project of Foray 48B following recommended guidelines.

5. **Microbial research.**

The committee recommends maintaining and increasing support of microbial and pheromone research for improved pest monitoring and suppression research.

6. **Joint Meeting of Western and Gypsy Moth and Other Eastern Defoliators Steering Committees.**

The eastern committee has suggested that the two steering committees meet jointly and the committee concurs. It is proposed that the committees meet during October 1990 at a mutually agreed to city (eg., Atlanta, Seattle, Salt Lake City, Denver, St. Louis, Pittsburg, or Kansas City). The respective committees would meet concurrently followed by a joint one day session.

7. **B.t. products.**

Currently registered B.t. products for Douglas-fir tussock moth and western spruce budworm, and their respective undiluted application rates for 16 BIU's per acre are listed below.

| Product | Application Rate | Registration DFTM[1.] | WSBW[2.] |
|---|---|---|---|
| Thuricide 32LV | 64 oz | X | X |
| Thuricide 48LV | 43 oz | X | X |
| SAN 415 | 64 oz | X[3.] | X[3.] |
| Dipel 6L | 43 oz | X | X |
| Dipel 8L | 32 oz | X | X |
| Dipel 6AF | 43 oz | X[3.] | X[3.] |
| Dipel 8AF | 32 oz | X[3.] | X[3.] |
| Foray 48B | 43 oz | X[3.] | X[3.] |

1. DFTM = Douglas-fir tussock moth.
2. WSBW = Western spruce budworm
3. Not registered for forestry use in California.

8. **Acephate (Orthene).**

The committee recommends that WO-FPM investigate opportunities to seek re-registration of acephate for control of forest defoliators.

## III. ACCOMPLISHMENTS

Summarized below are accomplishments related to 1988 committee recommendations.

A. Laboratory and Field Experiment Testing

1. Ecogen, Condof, (HD-269) Bacillus thuringiensis (B.t.) was field tested.

2. New strains of B.t. were screened on an on-going basis.

B. Pilot Project Testing

Novo, Foray 48B (HD-1) B.t. was pilot tested.

C. Other

1. Incident Command Systems (ICS) system has been incorporated in current draft revision of FSH 2109.11, chapter 3.

2. WO-FPM in cooperation with FIDR has met with EPA concerning need to ease rules on registration of pheromones and issuance of experimental use permits.

3. There is increased cooperation and interacting among FIDR and FPM scientists.

4. Cooperative field projects were conducted by FIDR and FPM.

5. Traditional approach to field testing and pilot projects is being supported and maintained.

6. Steering committee is being maintained.

7. Guidelines for conduct of field tests and pilot projects have been drafted, reviewed, and submitted to Director, WO/FPM.

8. Preliminary procedure for accessing and summarizing a data-base of past spray projects has been developed.

9. Field training for use of aerial spray models has been accelerated with several hands-on workshops conducted and five other workshops scheduled over the next four months. FSCBG model was run in support of control projects in R-1, R-4, and R-5.

D. Reports

Project reports are enclosed in Appendix B.

## IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Western Defoliators met in Albuquerque, October 11-12, 1989, to review events since the 1988 meeting, and to identify testing and related needs. The steering committee is evolving from its initial role of evaluating pilot project testing needs to that of identifying needs and recommending laboratory, developmental, field testing and pilot projects of pesticides, equipment, and strategies. The committee established operating guidelines at this meeting and prepared a listing of recommendations subdivided into six categories. The committee emphasizes that to address the needs and recommendations stated herein there is need for continued close cooperation among FPM, PNW, and PSW scientists; and for continuous of the PNW pesticide and microbial laboratories.

***********************************

APPENDIX A
Committee Operating Guidelines

# OPERATING GUIDELINES
# FOR
# NATIONAL STEERING COMMITTEES
# CONSIDERING
# FIELD TESTS AND PILOT PROJECTS
# FOR THE
# AERIAL APPLICATION OF PESTICIDES

MEMBERSHIP: Committees members should be nationally recognized research, developmental, and applied scientists as well as natural resource professionals drawn for the most part from the Forest Service but also from other Federal and State agencies.

PURPOSE: The committees' primary tasks are to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperators ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

PROCEDURES:

The committees shall:

- meet at least annually, preferably during late summer or early fall so recommended projects can be considered for approval, funding, and implementation the next field season.

- focus on sound science that may lead to improving pesticide application consistent with its stated purpose.

- assign priorities to testing needs agreed to by the committee.

- review data and progress of field and pilot tests.

- suggest who might conduct future tests and where the tests might be conducted.

- take action to address needs such as development of guidelines for field test and pilot projects, database formats, and literature studies.

- establish sub-committees to pursue single issues such as review of laboratory and field test data.

The members shall:

- determine pesticide application needs within their geographical, administrative or organizational area prior to each meeting.

- be cognizant of all appropriate Region/Area/Station/State/cooperator needs.

- bring to the meeting needs that have been discussed with line officers and staff.

- represent the unit's needs within the national perspective of the committee.

The Director FPM/WO shall:

- coordinate the report recommendations within WO, and with the Regions, NA, and Stations as appropriate.

- review the steering committee recommendations and resultant FPM project proposals for funding.

- give strong consideration to the steering committees recommendations in prioritizing project proposals for funding.

- complete project approval and funding by January for projects funded by FPM.

APPENDIX B
R-3

AERIAL APPLICATION OF PESTICIDES
WESTERN DEFOLIATORS STEERING COMMITTEE

Project Report For Region 3
October 11-12, 1989

Western Spruce Budworm (WSB) decreased significantly in its activity throughout Region 3. Forest defoliation caused by this insect decreased from 195,700 hectares in 1988 to 36,750 hectares in 1989.

No aerial suppression projects were conducted in the region in 1989; however, ground application of Bacillus thuringiensis (B.t.) wwere undertaken to protect foliage from WSB defoliation. In the Camino Real RD of the Carson National Forest, thirteen (13) campgrounds were treated with Thuricide 32LV and an adjuvant (Stick). The treated campgrounds encompassed a total area of approximately 31.2 hectares and were treated during the week of June 5 when the majority of the buds in Douglas-fir were fully flushed and budworm larvae were in the 3rd and 4th instar.

Applications were made using a ground hydrolyic sprayer made by Thorco Master Sprayers. The biological insecticide was applied to the foliage at a dosage rate of 1/2 gallon (16 BIU's) per 100 gallons of solution. A sticker (Stick) was added to the tank mix at a rate of one (1) pint per 100 gallons of mix.

Post treatment ofservations indicated foliage was protected and visual quality maintained by treatment.

10/11/89

National Steering Committee, Aerial Application of Pesticides - Western Defoliators

Project Report for R4

**Gypsy Moth Eradication Project - Salt Lake City, Utah**

Site: Salt Lake City - 1200 Ac in the Olympus Cove area

Applications: 3 applications of Dipel 8L

Application Aircraft: Jet Ranger 206 B3

Spray System: Simplex pump, Beecomists

Results: Significant population reductions have occurred in most areas within spray block. One area within the heavily infested core was evidently skipped. Perimeter apparently didn't receive adequate coverage.

Plans for 1990 project: The project area will probably increase to at least 20,000 ac. The area sprayed in 1989 will be included in the spray blocks designated for 1990. In addition areas near Bountiful and Provo will be treated.

APPENDIX B
R-5

In 1987 about 7,000 acres on the Plumas NF, Lassen NF and intermingled private lands were defoliated with DFTM . After evaluating the outbreak and treatment alternatives, the Plumas Forest Supervisor decided to conduct a field/pilot test using Bacillus Thuringiensis (BT). At the time of the decision BT was only registered at 8 BIU/acre for DFTM. The test compared the efficacy of an 16 BIU/acre doses applied at either 128 oz/acre or 64 oz/acre. Each treatment was replicated four times with 5200 areas being treated. An AT-301 Air Tractor was used to make the applications using six Microaire AU 500 rotary nozzles. Population reductions are summarized in Table 1.

In the fall of 1988 an addition 80-90,000 acres were found to be infested with DFTM. The results of the NEPA analysis led to the decision to treat the outbreak with 16 BIU of BT (Thuricide 32 LV, the only formulation registered at that dose in CA at the time of the decision). The objective of the operational project was to reduced tree mortality by reducing the DFTM population by 80%. Because of the results from the prior field/pilot test we prescribed treating the population at 50% dispersal instead of waiting for 10 days after hatch and dispersal (the old application timeing). Application was made with eight Turbo Air Tractors equiped with 8010 flat-fan nozzles. Applications rate was 128 oz/acre with an atomization of 162 to 190 microns. Population reductions are summarized in Table 2. The early application provided substantial foliage retention. We estimate that we protected 50% of the new foliage on the majority of the 83,871 acres treated.

[illegible] 23 [illegible] the 21 [illegible] and increasing [illegible]

[illegible]

The fall of 1989 [illegible]

[illegible] with [illegible]

[illegible] at 50% [illegible]

[illegible] capacities [illegible]

majority of the 81,677 [illegible]

Table 1.

[a] COMPARISON OF DFTM POPULATION REDUCTION AFTER TREATMENT WITH 16 BIU OF BACILLUS THURINGIENSIS AT 128 OZ/AC VERSUS 64 OZ/AC-PLUMAS NF, 1988.

| TREATMENT (oz/ac) | LARVAL DENSITY[a] PRESPRAY | PERCENT REDUCTION |
|---|---|---|
| 128 | 452.5 | 92.5 |
| 64 | 558.4 | 88.6 |
| CONTROL | 467.1 | 78.2 |

[a]NUMBER OF LARVAE PER 1000 SQ. IN. OF FOLIAGE

Table 2.

DFTM POPULATION REDUCTION - LASSEN/PLUMAS DFTM PROJECT, 1989

| UNIT | LARVAL DENSITY PRESPRAY | PERCENT REDUCTION |
|---|---|---|
| PLUMAS | 200.7 | 88.4 |
| LASSEN | 203.4 | 90.1 |

APPENDIX B
R-6

MESSAGE SCAN

To  I.RAGENOVICH
CC  J.BARRY:SCS06

From: James S. Hadfield:R06A
Postmark: Sep 29,89 7:52 AM    Delivered: Sep 29,89 7:54 AM
Status: Previously read
Subject: WESTERN DEFOLIATORS

---

Comments:
IRAL, I HAVE BEEN ACCUMULATING SUGGESTIONS FOR AERIAL APPLICATION OF PESTICIDES-WESTERN DEFOLIATORS STEERING COMMITTEE. HERE THEY ARE.

--------========X=============-------

These are suggestions and thoughts I offer up to you for consideration by the Aerial Application of Pesticides, Western Forest Defoliator Steering Committee at the October meeting in Albuqueque.

Pilot Tests-- Based upon my recent personal experience,decisions to do pilot tests should, at a minimum, be made while the candidate sites are accessible and while there is some reasonably observable evidence of the target insect populations present. This means early summer for the most part. In my opinion pilot tests should be planned at least 1.5 years ahead of their execution so ample time is available to find suitable sites, which means accessible terrain and a healthy insect population.

I feel the only product that should be pilot tested for western spruce budworm control is SAN 415 SC produced by Sandoz. It should be tested at 16 BIU applied undiluted at 64 ounces per acre.

We seem to have informally settled on Thuricide 32 LV as a standard that we compare other BT products to. If there are more pilot tests, I reccomend that Thuricide 32 LV, applied undiluted at 16 BIU in 64 ounces per acre, be included as a treatment so we can, in fact, compare other treatments to it.

Do not pilot test Dipel 8L or any BT product at rates less than 43 ounces per acre. The reason is these low volume applications seem to have a high potential for failure. Sometimes they work. Sometimes is not good enough. Let Abbott Labs test Dipel 8L at low volumes.

I am of the opinion that we could probably do away with pilot tests and go directly from a well designed field test to operational use of a product. I feel the only potential advantage offered by a pilot test compared to a field test is the opportunity to observe handling features of the product applied to a large acreage. This advantage can be largely offset by having 4 to 5 replicated blocks of about 50 acres, each treated on separate days. Applications could also be applied to some of the blocks under less than optimum conditions to simulate conditions likely to be experienced in operational projects. A field test may cost about $100,000, a pilot test is likely to cost $500,000. I do not believe the extra $400,000 is worth it.

The Forest Service should encourage BT producers to do field tests on their own. We need to help them by making sites available, and possibly some equipment. Another prospect is to contract pilot and field tests with private companies. We could conceivably get caught up in an endless series of tests because the producers are continuing to modify existing products and develop new ones. Time to break new ground.

Field Tests-- Do not test any Ecogen product in the field. Let Ecogen test on their own.

Do field tests of TM Biocontrol-1 at doses lower than that presently recommended for control of DFTM.

[illegible]

[illegible] Dalimon, [illegible]

[illegible]

[illegible] Samples. [illegible]

[illegible]

[illegible] [illegible] TN 17, [illegible]

[illegible] concentrated [illegible]

[illegible] that test Giegy [illegible] [illegible] failure. Sometimes they doubt [illegible] is not good enough. [illegible] Dryol 51 at low dilutions.

[illegible] of the opinion [illegible] [illegible] directly from a well designed field [illegible] [illegible] the only percent of [illegible] [illegible] in the apparatus [illegible] large acre [illegible] This advantage [illegible] [illegible] about 50 acres [illegible] [illegible] [illegible] applications could also be applied [illegible] [illegible] conditions [illegible] [illegible] recommendations [illegible] [illegible]

[illegible] should as average [illegible] to do field tests [illegible] [illegible] giving, alive [illegible] [illegible] [illegible] [illegible] [illegible] and field [illegible] prices.

[illegible] accidentally get caught up [illegible] [illegible] [illegible] product [illegible]

[illegible] Field Tests-- Do not test any Geigy product in the field. Let Geigy test it [illegible].

[illegible] field tests of TN Microtol-1 at doses lower than that necessary [illegible] recommended for control [illegible].

Do a field test of BT (maybe Thuricide 32LV or Dipel 6L) against suboutbreak populations of DFTM to determine if outbreaks can be prevented or if spot treatments can be effective.

Do a field test of TM Biocontrol-1 against suboutbreak populations of DFTM to determine if outbreaks can be prevented or if spot treatments can be effective.

Other Tests--There is a need to test application and monitoring procedures so that the most efficient and effective approaches are being used to apply insecticides.

Guidance systems that allow application pilots to accurately determine their location and place their swaths without close monitoring by observation helicopters carrying government inspectors has the potential for reducing the cost of application. Pathlink has not worked satisfactorily in past test efforts. Available technology should be evaluated and modified as approppriate to fit forestry applications.

Aerial observation of spray aircraft from helicopters should be compared to that from airplanes. Thoroughness of coverage of the target areas with insecticides, amount of misapplication (double coverage, spraying outside blocks), and cost of observation should be compared.

We need procedures for testing the potency of BT products after they have been produced by the manufacturer but before the Forest Service applies them in the forest. In other words let's make sure the stuff is viable before it is sprayed.

There is still a need for some form of spray deposit assessment. I would like to have the Kromekote twigs used in eastern Canada tested as a collection device in comparison to flat Kromekote cards placed on the ground.

This falls in the area of research. There is a need to develop or test carriers for TM Biocontrol-1. The existing procedure has a high potential for causing logistical problems if large acreages would need to be sprayed. We would like to be able to apply TM Biocontrol-1 at 64 ounces per acre.

The CASPR model should be field tested to determine if it can be used to help design application projects or if modifications are needed.

Consider doing further field validation of AGDISP and FSCBG by comparing the predictions to actual measurements collected on an operational project, such as the potential WSBW project at Yakima Indian Reservation.

Test the "Twardus" application monitoring system on western defoliator suppression projects to determine its applicability and/or need for modifications.

1989 WESTERN SPRUCE BUDWORM PILOT TEST, HALFWAY, OREGON, WALLOWA-WHITMAN NATIONAL FOREST. PACIFIC NORTHWEST REGION

LOCATION: Pine, LaGrande Ranger Districts and Hells Canyon National Recreation Area, Wallowa-Whitman National Forest, Oregon.

INSECTICIDE: Foray 48B. Treatment # 1. Foray 48B applied undiluted at the rate of 16 BIU in 42.7 ounces per acre. Treatment # 2. Foray 48B applied diluted with inactivated Foray 48B at the rate of 16 BIU in 64 ounces per acre.

APPLICATION: Hiller-Saloy 12Es equipped with 6 Beecomist 360A atomizers. Contractor, Western Helicopter Services, Newberg, Oregon.

TEST ACRES: 7,200. Acres sprayed 5129.

COST: $500,000

TEST DESIGN: Three treatments, Foray @ 1/3 gallon/acre, Foray @ 1/2 gallon/acre, and no spray. Each treatment was replicated four times. A complete set of treatments was applied each treatment day. Treatments were assigned at random to test blocks.

DISCUSSION: The purposes of the pilot test were to determine if the insecticide treatments could reduce the WSBW population to 1 or less insects per sample branch and to compare the two volumes of 1/3 to 1/2 gallons per acre. Test blocks had to have WSBW early larval densities of at least 12 with 90% confidence levels to qualify. A total of 12 test blocks, averaging 500 acres each were used. Prespray populations measured 1 day before spraying were high, averaging 24.5 WSBW per sample branch. Post-spray density averaged 4.8, 3.5, and 13.5 for the 1/3 gallon, 1/2 gallon, and 0 gallon applications, respectively. Budworm mortality, uncorrected for natural mortality, averaged 82, 85, and 44 percent for the 1/3 gallon, 1/2 gallon, and 0 gallon applications, respectively. Post-spray densities are statistically different between the treated blocks and the control blocks, but not between the two volumes. Spray deposition was rated good to excellent for the treatments. There were no handling problems with the Foray. The application contractor remarked that Foray was the easiest handling BT product he had ever used.

Other "new" approaches were used on the Halfway pilot test. Practically all supplies and equipment, other than that provided by the application contractor, were ordered from the Redmond Air Center using the ICS resource ordering system. This approach was highly successful.The contract required the applicator to use his personnel to mark the spray blocks, rather than have Forest Service employees do it. This also worked well, but the contract language needs to be improved to reduce potential for misinterpretations. Another approach new to R-6 involved placement of fluorescent panels on the ground by Forest Service employees laying out test blocks. This aided the contractor in his marking.

1989 WESTERN SPRUCE BUDWORM SUPPRESSION PROJECT, HIGH ROCKS, MT HOOD NATIONAL FOREST.

LOCATION: Clackamas Ranger District, Mt Hood National Forest, Oregon.

INSECTICIDE: Dipel 6L applied undiluted at the rate of 16 BIU in 42.7 ounces per acre.

APPLICATION: Bell 47G equipped with 6 Beecomist 360A atomizers. Contractor, Ptarmigan Helicopters, Evergreen, Colorado.

ACRES TREATED: 7454

COST: $155,000

DISCUSSION: The High Rocks operational project was carried out in June and July. The project area is located in the high Cascades, and was characterized by steep terrain with many aspects. The project area was divided into 20 separate spray blocks because of the terrain. The early larval density average for all 20 blocks was 15.2 WSBW per sample branch, with a range of 1.3 to 38.0. Spraying began on June 21 and ended on July 7. Spraying occurred on 9 days. The post-treatment density measured 14-to-21 days after application averaged 5.5 WSBW per sample branch. The target of the project was to reduce the WSBW population to 1 or less. The reasons for the disappointing population reduction are not known. The project area and surrounding stands sustained moderate to severe defoliation.

1989 HIGH ROCK PROJECT
DATA SUMMARY

| BLOCK NUMBER | NUMBER OF PLOTS | DATE EDENS | MEAN EDENS | DATE LAST DEVELOP | PERCENT L2 & L3 | PERCENT UNFURLED | DATE RELEASED | DATE SPRAYED | DATE POSTDENS | MEAN POSTDENS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 6/8/89 | 5.3 | 6/24/89 | 0.0 | 97.3 | 6/24/89 | 6/26,27/89 | 7/10/89 | 1.7 |
| 2 | 3 | 6/6/89 | 8.0 | 6/24/89 | 1.6 | 78.9 | 6/26/89 | 6/27/89 | 7/11/89 | 7.0 |
| 3 | 3 | 6/9/89 | 10.3 | 6/24/89 | 2.0 | 85.5 | 6/24/89 | 6/27/89 | 7/14/89 | 3.7 |
| 4 | 3 | 6/11/89 | 9.0 | 7/5/89 | 0.0 | 99.1 | 7/6/89 | 7/7/89 | 7/27/89 | 2.7 |
| 5 | 3 | 6/8/89 | 17.7 | 7/1/89 | 10.1 | 84.7 | 6/29/89 | 7/5/89 | 7/19/89 | 7.0 |
| 6 | 4 | 6/11/89 | 26.7 | 7/1/89 | 0.8 | 74.9 | 6/29/89 | 7/2/89 | 7/21/89 | 10.7 |
| 7 | 5 | 6/6,8,9/89 | 12.8 | 6/28/89 | 2.1 | 98.2 | 6/29/89 | 7/1/89 | 7/18/19/89 | 5.1 |
| 8 | 3 | 6/5,11/89 | 2.2 | 6/20/89 | 0.0 | 85.9 | 6/17/89 | 6/21/89 | 7/12/89 | 0.2 |
| 9 | 3 | 6/11/89 | 26.0 | 6/29/89 | 1.6 | 71.4 | 6/29/89 | 7/1,2/89 | 7/20/89 | 13.0 |
| 10 | 3 | 6/9/89 | 5.3 | 6/29/89 | 0.8 | 95.2 | 6/17/89 | 7/1/89 | 7/18/89 | 4.7 |
| 11 | 3 | 6/9/89 | 25.0 | 6/27/89 | 0.0 | 90.2 | 6/27/89 | 6/28/89 | 7/12/89 | 5.3 |
| 12 | 3 | 6/8,11/89 | 11.0 | 7/5/89 | 1.3 | 90.7 | 7/6/89 | 7/7/89 | 7/27/89 | 2.8 |
| 13 | 3 | 6/7/89 | 14.0 | 6/27/89 | 0.0 | 96.4 | 6/27/89 | 6/28/89 | 7/19/89 | 1.0 |
| 14 | 3 | 6/7/89 | 32.0 | 6/29/89 | 3.4 | 83.7 | 6/29/89 | 7/1/89 | 7/15/89 | 5.7 |
| 15 | 3 | 6/9/89 | 1.3 | 6/24/89 | 0.0 | 91.8 | 6/24/89 | 6/26/89 | 7/11/89 | 0.7 |
| 16 | 1 | 6/12/89 | 25.7 | 6/27/89 | 0.0 | 92.4 | 6/26/89 | 6/27/89 | * | * |
| 17 | 3 | 6/7/89 | 38.0 | 7/1/89 | 1.9 | 86.2 | 6/29/89 | 7/2/89 | 7/24/89 | 14.3 |
| 18 | 4 | 6/9,11/89 | 23.5 | 7/3/89 | 2.5 | 98.6 | 6/19/89 | 7/6/89 | 7/27/89 | 4.7 |
| 19 | 3 | 6/7/89 | 15.3 | 7/2/89 | 3.4 | 96.5 | 7/2/89 | 7/5/89 | 7/19/89 | 15.3 |
| 20 | 2 | 6/12/89 | 19.3 | 6/27/89 | ** | ** | 7/2/89 | 7/5/89 | 7/26/89 | 11.7 |
| TOTAL | 61 | ------ | 15.2 | ------- | --- | --- | ------ | ------ | ------- | 5.5 |

* Plot outside of spray area, no post-treatment sample taken.

** Due to inaccessibility, release based on Block 19 development data.

1989 Western Spruce Budworm Suppression Project, Boise Cascade, Simcoe, Washington

Location: Boise Cascade, Simcoe Pass, Washington

Insecticide: Sevin 4-Oil (carbaryl) 1 lb. a.i. per acre

Application: Hiller Soloy, Western Helicopters, Newberg, Oregon

Acres Treated: 1,500

Discussion: Two blocks totaling 1,500 acres were treated on Boise Cascade land with carbaryl. The two blocks were 380 acres and 1,120 acres in size and were located 8 miles apart. Entomological information was collected by the Washington Dept. of Natural Resources. Limited manpower resulted in a minimum number of samples per spray block. The sampling design for each block consisted of three sample plots per block, two sample trees per plot, and two branches per tree. An early larval density was taken on May 26, the prespray sample was taken on June 15, and the postspray sample was taken 14 days after treatment, on June 29. The following is a summary of the project results. Larval densities are numbers of larvae per 45 cm branch tip.

| Block | Acres | Early Density | Prespray | Postspray |
|---|---|---|---|---|
| Pipeline | 380 | 40 ± 14 | 33 ± 18 | 0 |
| Devil's Canyon | 1,120 | 41 ± 19 | 27 ± 14 | .06 ± .2 |

No check plots were taken, however, a walk through of areas adjacent to the treated areas at the time of the postspray sample showed active larval feeding and sixth instar larvae spinning from webs.

1988 Meacham Pilot Project, Umatilla National Forest, Oregon
One Year Post Treatment Sampling

Location: Umatilla National Forest, Oregon

Treatments: Dipel 6AF at 42.7 oz/ac undiluted;
Thuricide 48LV at 42.7oz/ac undiluted
Check

Discussion: In 1988, the Meacham Pilot Project was conducted. The Pilot Project consisted of 3 replicates each of two B.t. products and the check. The sample design consisted of 25 sample plots per treatment block, with three sample trees per plot. The purpose of the 1989 sampling was to quantify the short-term effects of the treatments on western spruce budworm population reduction and defoliation, by measuring the 1989 budworm population densities and defoliation. The 1989 measurements were taken at approximately the same time as the 1988 post-treatment samples were taken, at the start of pupation on the blocks. Sampling was done in the same manner as the post-treatment sampling: that is, four 45 cm. branches were taken from the midcrown of each sample tree. Samples were processed in the field, and total counts of budworm were made, including larvae, pupae, and pupal exuviae. An estimate of defoliation was made using the six-class system.

Data are currently being analyzed by MAG biometricians. Not all information is available at this time, however, the following table shows 1988 pre-treatment and post-treatment densities, and the preliminary 1989 one year post-treatment densities.

1988 Meacham Pilot Project Pre- and Post- Treatment Densities and 1989 One Year Post-Treatment Densities

(Budworm per 45 cm. branch)
(mean ± SE )

| Block | 1988 Pre-Spray | 1988 Post-Spray | 1989 Post-Spray |
|---|---|---|---|
| 4D | 19.6 ± 1.9 | 3.5 ± 0.5 | 1.4 |
| 5T | 20.6 ± 1.0 | 1.6 ± 0.4 | 0.2 |
| 6C | 23.2 ± 2.5 | 9.6 ± 1.0 | 5.4 |
| 7C | 17.2 ± 1.1 | 8.6 ± 0.8 | 4.3 |
| 8T | 18.0 ± 1.6 | 0.7 ± 0.1 | 0.7 |
| 9D | 18.0 ± 1.1 | 2.1 ± 0.4 | 3.1 |
| 10D | 15.8 ± 1.2 | 0.9 ± 0.2 | 0.9 |
| 12T | 19.4 ± 2.0 | 0.8 ± 0.2 | 2.5 |
| 13C | 11.6 ± 0.9 | 5.6 ± 0.4 | 3.3 |

post-treatment densities are unadjusted for mortality

Treatment Summary

| Treatment | 1988 Pre-Spray (mean ± SE) | 1988 Post-Spray (mean ± SE) | 1989 Post-Spray |
|---|---|---|---|
| Dipel 6AF | 17.8 ± 0.9 | 2.17 ± 0.2 | 1.8 |
| Thuricide 48LV | 19.3 ± 0.9 | 1.0 ± 0.2 | 1.1 |
| Check | 17.3 ± 1.1 | 7.9 ± 0.5 | 4.3 |

APPENDIX B
PNW

# 1989 WESTERN SPRUCE BUDWORM FIELD TEST OF CONDOR AF AT ENTERPRISE, OREGON

Location: Wallowa Valley Ranger District, Wallowa-Whitman National Forest, Oregon. Project site north-northwest of Enterprise, Oregon.

Insecticide: CONDOR AF applied at three dosages using a constant spray application volume.

Application: Bell 47 helicopter equipped with 6 Beecomist 360A Rotary Atomizers on a standard spray boom. Contractor, Western Helicopter Services, Newberg, Oregon.

Test Acreage: 320 hectares (240 treated + 80 untreated checks).

Test Design: Randomized Block Design. Five blocks containing four 16-ha plots each. Within each block, the treatments and untreated checks were ranomly assigned to the plots; therefore, each treatment was replicated five times. A single block was treated each day with the order of plot treatment randomly assigned.

Pre- and postspray population sampling was conducted on 30 trees per plot using a single 45 cm midcrown branch per tree. In addition, foliage bioassays were collected at 0-hour, 1-, 5-, 10-, and 20-days to determine persistance of the Bt.

Discussion: Logistically, the spray operation went exceptionally well; spraying began on June 17 and was completed on June 24 with a 3-day layoff between blocks 2 and 3 because of cool, inclement weather. The larval populations were predominately 4th and 5th instars at the time of spray application. The use of balloons and large orange panels on the plot corners, and the experience of the pilot ensured that the spray reached the proper target as verified by ground observers.

The population sampling showed that there was no significant difference between any of the treatments and the untreated checks (Attachment I). The 0-hour bioassay also showed poor kill; normally, one would expect >90% kill when the foliage is collected immediately after spraying and forced upon laboratory insects. We tested the tank water against distilled water in our Corvallis laboratory to determine if the water was responsible for deactivation of the Bt. We used Thuricide 32LV, Foray, and Condor during the test. The laboratory results (Attachment II) showed that the field results were not due to the water source.

Boom samples were collected after each spray operation and tested using a diet incorporation technique. Preliminary results show that the material introduced into the diet at the rate of 10 ug per ml of diet will kill the test insects; the next step is to produce $LD_{50}$ curves through a dilution process of each test material. Lloyd Browne, Ecogen representative, was on site at the heliport during the first day of spraying. During subsequent discussions with him about the results, he mentioned the possibility that the sticker may have encapsulated the active Bt by drying during the fine-droplet settling to the target under our field conditions. Both Ecogen and PNW are trying to resolve the problem that occurred in the 1989 test.

Attachment I

Pre and Postspray Sampling of Western Spruce Budworm
Condor AF Test, Enterprise, OR, 1989

| Treatment | Plot | Mean #Insects per Branch Prespray | Postspray |
|---|---|---|---|
| 16 BIU | 1 | 12.4 | 7.3 |
| | 8 | 17.3 | 9.3 |
| | 11 | 18.0 | 9.4 |
| | 16 | 18.0 | 7.7 |
| | 19 | 21.4 | 4.8 |
| Mean | | 17.42 | 7.70 |
| 8 BIU | 2 | 18.4 | 12.9 |
| | 6 | 20.5 | 9.3 |
| | 9 | 16.7 | 8.6 |
| | 13 | 14.4 | 4.4 |
| | 18 | 18.2 | 11.2 |
| Mean | | 17.64 | 9.28 |
| 4 BIU | 3 | 13.9 | 7.0 |
| | 5 | 17.9 | 11.1 |
| | 10 | 22.3 | 7.0 |
| | 15 | 19.7 | 6.4 |
| | 20 | 22.1 | 8.7 |
| Mean | | 19.18 | 8.04 |
| Check | 4 | 15.1 | 7.3 |
| | 7 | 9.5 | 5.9 |
| | 12 | 20.5 | 12.7 |
| | 14 | 20.3 | 6.9 |
| | 17 | 23.8 | 6.9 |
| Mean | | 17.84 | 7.94 |

Attachment II

WATER TEST TO DETERMINE EFFECT ON Bt

| Treatment | Water Source[1] | Replication | # Dead | Percent Bt Killed[2] |
|---|---|---|---|---|
| Thuricide | Distilled | 1 | 22 | 100 |
| | | 2 | 24 | 100 |
| | Tank | 1 | 24 | 100 |
| | | 2 | 23 | 100 |
| Novo | Distilled | 1 | 24 | 100 |
| | | 2 | 21 | 100 |
| | Tank | 1 | 25 | 100 |
| | | 2 | 24 | 100 |
| CONDOR OF | Distilled | 1 | 20 | 100 |
| | | 2 | 19 | 100 |
| | Tank | 1 | 24 | 100 |
| | | 2 | 18 | 100 |

[1] Distilled water from Corvallis Laboratory; Tank water obtained from the water truck used on the 1989 spray test.

[2] Based on 10 randomly chosen dead larvae in each replication of 25 insects. Bt verification by use of a compound microscope with phase illumination.

APPENDIX C
Guidelines - Field Experiments
and Pilot Projects

# RECOMMENDED GUIDELINES FOR DESIGN OF PILOT PROJECTS - AERIAL APPLICATION OF PESTICIDES (**DRAFT**) 8-31-89

## I. INTRODUCTION

### A. General

The USDA Forest Service (FS) conducts pilot projects to evaluate operational use of pesticides, application systems, and strategies to manage forest pests. Decisions to proceed with a pilot project are based upon current or projected needs of the FS and availability of research data to support the new technology. Pesticides, application systems, and strategies customarily are researched or developed through the field testing stage, by the FS, other agencies, universities, or the private sector prior to being evaluated on a pilot project. Occasionally circumstances may dictate that a pesticide, application system, or strategy be pilot tested prior to completing research and development. In such cases the test may be a cooperative field and pilot project, with characteristics of both types of testing, but with major emphasis on an operational-scale variable. Pilot project design and conduct will vary depending upon test objective, criteria, and evaluation criteria e.g., evaluating biological effectiveness vs evaluating engineering performance of a spray system.

### B. Purpose

The purpose of this document is to set forth a set of broad guidelines for planning and conducting pilot projects involving aerial application of pesticides, application systems, and strategies. Persons intending to conduct pilot projects are encouraged to follow these guidelines.

### C. Background

The agency (FS or State cooperator) intending to use the pesticide, application system, or strategy operationally usually will participate in conducting the pilot project. In the process of conducting the pilot project the agency prepares for operational deployment of the pesticide, application system, or strategy. Thus, the agency determines during the pilot project whether it can use the pesticide, application system, or strategy effectively under operational conditions. To this end objectives might not be met if the pilot project were contracted to a non-agency entity. There are, however, special circumstances when a contractor might be appropriately contracted to conduct portions of a pilot project, e.g., weather monitoring, biological or spray deposit sampling, or laboratory assessment activities.

### D. Scope

The scope of this document covers pilot projects to evaluate the operational use of aerial application of pesticides, application systems, and strategies. The guidelines are oriented toward pesticide application projects; however, they are also applicable to pilot project evaluation of equipment and strategies. These guidelines are for use by public agencies and the private sector.

E. Definitions

Administrative Project (Study) - A special project conducted for a special local need of a District or Forest. The project may or may not include an accepted statistical design.

Application Systems - Spray application equipment that may include 2 or more of the following: aircraft, nozzles, aircraft guidance system, spray monitoring equipment, and other new eqiupment.

Control (Checks) - A series of experimental units (i.e., plots) receiving no treatment and/or a standard treatment; and included in the experiment or pilot project under the same conditions as the treatment.

Cooperative Field and Pilot Project - A field project conducted cooperatively by FIDR and FPM that meets objectives of both a field test and a pilot project, and that meets the statistical design criteria of a field test.

Demonstration - A special project to demonstrate effectiveness of a product, equipment, or strategy; with or without the benefit of an accepted statistical design.

Field Test - A research project designed to evaluate several treatment variables under field conditions.

Operational Projects - A full scale control project designed to utilize the best treatment materials, equipment, techniques, and strategies available to treat a forest pest problem.

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A project with an appropriate statistical design that simulates an operational-scale action, and considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy. More than one variable (e.g., pesticide), however, may be tested concurrently.

Randomization - The assignment of treatments to project units so that all units have an equal chance of being selected for treatment or as controls.

Replication - A treatment (including controls) which is repeated on two or more project units. Its function is to provide an estimate of natural variation and reduce confounding factors when measuring treatment effects.

Standard Treatment - A treatment using a product, equipment, or strategy for which the effectiveness is known or predictable.

Strategy - An approach to manage a forest pest that may include but not be limited to timing of treatment; size and frequency of treatment; combination of control methods; and other proven and unproven approaches.

## II. GUIDELINES

### A. Work Plan

A work plan should be prepared by the performing agency and coordinated with interested parties. The plan should include the who, why, what, when, where, and how of the project. The objective, methods, and analyses should be clearly stated and described. Work plans should also include operational aspects to include schedule of events, responsibilities, health and safety, and background information on the items being tested (e.g., pesticide labels, material safety data sheets, and equipment specifications). As a guideline, the work plan should include sufficient detail to allow another person or group to conduct the pilot project. The pilot project design should include data collection and analyses that collectively might explain failures and successes.

A typical work plan, therefore, should include the following sections:

1. Introduction and Background
2. Objectives and Tasks
3. Project Area Description Physical and Biological
4. Pesticide, Application System, or Strategy Description
5. Methods - Project Design
6. Pesticide and Equipment Handling Procedures
7. Field Sampling Procedures
8. Laboratory Procedures
9. Environmental Monitoring
10. Data Analysis
11. Administration, Organization, and Budget
12. Safety
13. Public Involvement
14. Reporting Results and Technology Transfer

### B. Criteria for Selecting Treatment Block

Criteria for selecting treatment blocks for pilot projects will vary depending upon objectives, available areas, environmental concerns, and other practical considerations. Most pilot projects will require

treatment replications and controls; therefore, blocks should be similar in size, elevation, exposure, stand composition, and in the case of pesticide application, the blocks should have comparable populations of pests. Control blocks should be located upwind of treatment blocks and at suitable distance to avoid spray drift. In addition they should be monitored for drift. Treatment blocks should be comparable in size to those that might be treated operationally. Size may range from a few acres (e.g., seed orchards and site preparation areas) to a few thousand acres (e.g., western spruce budworm control areas).

C. Criteria for Evaluation

A pilot project should have a sound rationale for its statistical design. For reasons discussed above the design will vary from project to project. It is suggested that the statistical design be reviewed by a statistician, by a research specialist, and by future users of the technology being tested. Design of pilot projects should include control (check) blocks and appropriate replication of the test treatment. In cases where replication or control blocks are not feasible, the pilot project objectives should be reviewed, and consideration given to conducting some alternative evaluation such as a special demonstration or an administrative project. When this is done it should be with the understanding that project results will not be as meaningful as those of a field test or pilot project with appropriate replications and checks.

Control and treatment blocks should be selected randomly from a group of blocks with similar characteristics. A minimum of three replications for both treatment and control blocks is recommended. All treatment blocks should be selected randomly for treatment, even recognizing that practical considerations may argue otherwise for treatment blocks, in particular. To select some blocks by other than a random approach, however, would be a serious departure from sound pilot testing in the sense that each area should have an equal opportunity to receive any treatment. To select by other criteria runs the risk of biasing test rationale and results of the evaluation.

D. Measurement of Biological Processes

The selection of appropriate sampling procedures to obtain statistically accurate estimates of population densities and, when necessary, to monitor population development, is essential for the successful completion of any pilot project. Sampling procedures should be described in detail in the work plan and final report. Population estimates obtained as a result of following the selected sampling procedure should be displayed with their attendant measures of variation (standard deviations, standard errors of the mean, etc.). At a minimum at least one pre-spray and one post-spray evaluation following the selected sampling procedures must be performed in both treated and untreated control blocks and the results reported. When treatment efficacy is affected by proper timing in relation to the

target pest population, pest and host phenology information, if known, describing the life-stage distribution of the population during treatment should be reported.

Most major target pests have published sampling procedures. Examples of publications dealing with sampling procedures for Douglas-fir tussock moth, western spruce budworm, and gypsy moth are listed below:

Douglas-fir tussock moth

Mason, R.R. 1970. Development of sampling methods for the Douglas-fir tussock moth, Hemerocampa pseudotsugata Lepidoptera: Lymantriidae). Can. Entomol. 102:836-45.

Mason, R.R. 1979. How to sample Douglas-fir tussock moth larvae. USDA Agricultural Handbook No. 547, 15 pp.

Mason, R.R.; Wickman, B.E.; Paul, H.G. 1989. Sampling western spruce budworm by counting larvae on lower crown branches. PNW-RN-486, 8pp.

Western spruce budworm

Carolin, V.M.; Coulter, W.K. 1972. Sampling populations of western spruce budworm and predicting defoliation on Douglas-fir in eastern Oregon. Res. Pap. PNW-149. Portland, OR, 38 pp.

Srivastava, N; Campbell, R.W.; Torgersen, T.R.; Beckwith, R.C. 1984. Sampling the western spruce budworm: fourth instar, pupae,and egg masses. Forest Science 30(4):883-892.

Gypsy moth

Wilson, R. W., Jr.; Fountaine, G. A. 1978. Gypsy moth egg-mass sampling with fixed and variable radius plots. USDA Agricultural Handbook No. 523, 46 pp.

Kolodny-Hirsch, D. 1986. Evaluation of methods for sampling gypsy moth egg mass populations and development of sequential sampling plans. Environ. Ent. 15:122-7.

Dubois, N.; Reardon, R.; Kolodny-Hirsch, D. 1988. Field efficacy of the NRD-12 strain of Bacillus thuringiensis against gypsy moth. J. Econ. Ent. 81:1672-1677.

Sampling procedures for some target pests may not be adequately addressed in published literature. In these cases procedures should be selected based on recommendations made by recognized specialists.

In addition to the sampling requirements detailed above, several other procedures may help a potential user interpret the results, and thus

improve the credibility and acceptance of pilot project results. Biological assays (tests of the performance of field applied pesticides in a controlled environment on susceptible lifestages of the target insect) help to ensure that reported differences between mortality rates in the treated and control blocks resulted from exposure to the pesticide. Measurement of the pesticide potency obtained by quantifying the amount of active ingredient in sub-samples of each field batch provides additional information on potential effectiveness of the pesticide. Implementing procedures within the pilot project to fill data gaps on the effects on non-target organisms are encouraged.

E. Measurement of Physical Processes

The physical environment may have a major impact on the performance of a pesticide, application system, or strategy. The physical environment should be considered during project design, conduct, and data evaluation and described in the pilot project report. It is assumed that the pilot project will be conducted at a location that is physically comparable to where it may be deployed operationally. Topography (elevation, slope, surface cover, and soil types) and atmosphere (wind, temperature, and moisture) can have a dramatic influence on performance of a pesticide, application systems, or strategies. Monitoring procedures and resulting data should be included in the report. To illustrate, application success in a low elevation, moderate terrain may not be repeatable in higher elevations and more complex terrain. Similarly, atmospheric conditions combined with topographical factors, may have a dramatic influence on dispersion of sprays and performance of equipment.

Meteorological measurements should be collected to:

1. Aid in spot forecasting and scheduling.

2. Provide the project director information for operational decisions.

3. Document events for post-spray analysis, modeling, and legal reference.

Two references on forest meteorology are:

Ekblad, R. B., H. E. Cramer, and R. K. Dumbauld. 1978. Meteorological considerations and measurements. In: The Douglas-fir Tussock Moth: A Synthesis; Forest Service, Science and Education Agency, Technical Bulletin 1585. U.S. Department of Agriculture, Washington, D.C.

Schroeder, Mark J. and Charles C. Buck. 1977. Fire Weather. Agriculture Handbook 360. U.S. Department of Agriculture, Forest Service, Washington, D.C.

F. Measurement of Physical Performance

The pilot project should provide for acquisition of data to evaluate the physical performance of the pesticide, application system, or strategy. This often is overlooked by scientists who may focus primarily on biological results. To illustrate with an example - you are testing a proven pesticide against a defoliator that concentrates in the upper tree crown. The test did not meet your control expectations and you may have doubts about its effectiveness. Why did it not perform? To evaluate this poor performance you need data on spray deposition in upper crown, spray atomization, aircraft calibration and performance, aircraft application, physical properties and handling of the tank mix, as well as information discussed in paragraphs II, E.

G. Environmental Monitoring

Design and conduct of pilot projects should consider environment protection consistent with the National Environmental Policy Act. Equal protection should be provided on private, State, and Federal lands. The pilot project objective should include determining or evaluating potential environmental impact of the pesticide, application system, or strategy being tested. Recognizing that such data may have been obtained during field or development testing, it is important to recognize that the purpose of a pilot project is to evaluate performance under semi-operational conditions. As an example, drift may be minimal on a 20 acre block when sprayed by a small helicopter close to the canopy, over moderate terrain. Scaling up from a 20 acre field experiment to a pilot project may involve several thousand acres, the aircraft may be a large helicopter or fixed-wing that flies higher above the canopy, and the terrain more complex.

Drift is inevitable - but how much and is there an impact? Such data are needed for operational evaluations.

H. Pesticide Application Equipment, and Strategies

The system being evaluated on a pilot project should be the system that in all probability would be deployed operationally. The project may be for a pesticide, an item of application equipment, a strategy, or a combination of these three. The pesticide tank mix, the aircraft and atomizer type, and strategy to be evaluated on a pilot project should be the same system planned for operational use; recognizing practical considerations.

WO/FPM staff is available to assist in reviewing work plans and operation plans, and providing advice as requested.

I. Reporting Results

Timely reporting of pilot projects is essential to efficient use of the technology being evaluated. A preliminary report should be available

within four months of completing the field operation and a final report within one year. Journal publications should be considered when appropriate. The preliminary report may be critical to budget planning of follow-on testing or for operational deployment of the tested product.

********

This draft 6-22-89 considered comments received from M.Ollieu, D.Hamel, and G.Daterman.

---

This draft 7-20-89 considered comments received from J.Weatherby, G.Daterman, R.Reardon, D.Hamel, and T.Hofacker.

---

This draft 8-31-89 considered comments received from WO-FIDR, WO-FPM (D.Hamel); NA (D.Kucera, J.Hanson, I.Millers); PNW (G.Daterman); R-6 (B.Ciesla); Idaho (L.Livingston); R-8 (J.W.Taylor); and R-2 (D.Johnson).

[illegible]

[illegible]
[illegible]

RECOMMENDED GUIDELINES FOR DESIGNING FIELD EXPERIMENTS OF INSECTICIDES FOR CONTROL OF INSECT DEFOLIATORS BY AERIAL APPLICATION

## PURPOSE

The purpose of this document is to set forth some guidelines that can be used by private industry, consultants, and others in planning field tests for aerial application of insecticides to control forest defoliators. This document describes the types of parameters and experimental design considerations that Forest Service scientists consider when evaluating the results of an insecticide field experiment to determine whether it warrants pilot testing. These guidelines are not meant to be rigid unalterable criteria, or exhaustive, but they will serve as a focal point for discussion in planning insecticide field tests.

## INTRODUCTION

The Forest Service, USDA, uses a progression of tests to evaluate and recommend various insecticides for use in operational resource protection. These include laboratory screening, field experiments, and pilot projects. Here, the term insecticides refers to any material distributed for the purpose of protecting a forest resource from insect pests, and may include agents that kill the pest with some form of toxicant, or other materials that prevent a necessary behavior such as feeding, mating, ovipositing, aggregation, etc. Field experiments are conducted to evaluate one or more of following; determine the minimum effective dosage rates, different strategies, or formulations of the same material, or different applications equipment. In contrast pilot projects evaluate the most promising treatments identified by field tests. Usually only one variable, for example dosage or volume, is evaluated and the plots are large enough to simulate operational conditions. These operational simulations include such items as uncontrolled multiple swathings, formulation and mixing characteristics of large quantities, use over wide variations in physical conditions etc.

Regardless of the type of program being conducted it is critical to state the objective clearly, concisely and as specifically as possible. The objective may be to estimate treatment effects (contrasting postspray populations levels in both treatment vs. control, or population reductions by treatment vs. control etc.) or specifications to be met (i.e. a treatment must reduce the population at least 90% to be judged effective). Some field tests of insecticides may be planned to determine the lowest effective dose to achieve a certain percent control or residual population for each treatment and to compare treatments. Usually, experiments with such general purposes are evaluated by analyses of variance (ANOVA) with appropriate contrast for determining differences in treatment means.

To arrive at an effective design for either hypothesis testing or point estimation we must consider variabilility and cost. Because the criteria for judging effectiveness for the two goals are different, the design parameters, such as number of plots (replicates), number of trees (subsamples within a replicate) may differ. In many instances, however, both hypothesis testing and

point estimation are important in a single field experiment. It seems reasonable then that the design parameters that meet the design criteria for one goal and exceed the criteria for another goal should be used.

All insecticides used by the USDA Forest Service are registered by the U.S. Environmental Protection Agency (EPA) under the authority of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended. However, additional research may need to be conducted on registered insecticides for the purpose of: (1) extending a registration to a new pest; (2) evaluating an insecticide's fate in the environment, (3) field testing an insecticides on a small scale, or (4) assessing environmental effects in specific forest habitats. When field tests are conducted on less than 10 cumulative acres,

experimental use permits (EUP) are not required. If research is done on an unregistered pesticide on more than 10 acres then an EUP is required and the guidelines in 40 CFR 172 must be followed. In addition to EUP's, it is usually appropriate to prepare a Forest Service pesticide-use proposal (FS 2100-2) for review, concurrence, and approval of the intended use.

## EXPERIMENTAL DESIGN

1. Treated Areas: The following should be considered when selecting areas to be aerially treated with pesticides:

(1) First, the physiological health (quality) of the pest population should be known. Use of pest populations with recent history of stresses (i.e., acute competition for food, starvation, high virus incidence, recent epizootics, high level of parasitic activity of other chronic microbial infections) should be avoided if possible or at the very least noted. Using such populations of low quality could cause confounding effects and raise doubt concerning the reliability of the test results.

(2) Block size should be based on two considerations: (a) mobility of the pest and (b) type of aircraft planned for use. Blocks of at least 20 acres should be used when the target pest is not mobile and blocks of at least 30 acres should be used if the target pest tends to be mobile. Helicopters should be used to treat small blocks.

2. Replication: The function of replication is to provide an estimate of experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects. The number of replications that will be required in a particular experiment depends on the magnitude of the differences to be detected and the variability of the data encountered. An experimental unit refers to the unit to which a treatment is applied. It can be a single leaf, an entire plant, or an area of ground containing many plants. Treatment replication is achieved when a treatment is randomly assigned to more than one experimental unit. Ensuring adequate replication within the confines of applicable constraints, such as manpower and cost, usually requires that treatment plots be small, i.e. 20-50 acre plots.

3. Randomization: Randomization functions to assure unbiased estimates of treatment means and experimental error. When conducting a field experiment to establish the efficacy of aerially applied insecticide in forestry, it is recommended that 2 or more variables (e.g., dose and volume) be tested in the same experiment. It is also further recommended that each variable be replicated 5X (no less than 3X will be accepted) and all treatments (including the fully replicated control) are to be assigned at random.

4. Sampling: Depending on the insect species, an appropriate sampling design must be described in detail so that population estimates can be displayed with their attendant measures of variation (standard deviations, standard errors of the mean etc.). Efficacy testing will be evaluated using

acceptable sampling designs. Treatment effects will be measured with, at minimum one pre treatment and one post-treatment estimate of the pest population's density. It is also highly recommended that periodic measurements to estimate treatment effects on the pest population density or of the protective effect of the insecticide be made at different time intervals. These intervals should coincide with the pest's own development rate or at different developmental stages, during the pest's active (e.g. feeding) period.

5. Data Analyses: To account for treatment differences, given natural differences and sampling error, the variables of interest must be defined i.e. the ratio of insects to foliage after treatment vs. before treatment. An estimate of this variable or other variables of interest and the components of the variances of the estimates can be computed on the basis of ratios of the plot means. Usually, the experiment will be designed to test differences between dose levels, or between treatments and control, for a number of insecticides. In this example, analysis of the experiment will then be evaluated by a one-way ANOVA with plot ratios as observations (experimental units) and insecticides at various levels with control treatments. Establishing confidence intervals for the treatment means provide an additional set of statistics that can be used to determine differences between treatments.

## REQUIRED ANCILLARY DATA

1. Plot Descriptions: It is often helpful to describe the stand characteristics within which the experiment was conducted. This can often be useful in extrapolating the results to other geographical areas other than where the original experiments were conducted.

2. Spray Measurements: At a minimum spray deposit cards should be used to obtain a verification of qualitative spray deposits.

3. Aircraft and Spray Characterization: Data must be provided that describes aircraft type, aircraft speed, flow rate, nozzle type, number of nozzles, swath width, volume delivered per acre/hectare, active ingredient per acre/hectare, drop size, some measure of droplet distribution, droplet density etc.

4. Product Quality: In some instances (e.g., microbial pesticides), it is appropriate to test for product potency (quality) prior to use of the product. This will require drawing a pretreatment sample/s for bioassay. Analysis can be directed at determination of potency but can also be used to determine contamination if desired. With chemical insecticides it is recommended that tank samples be taken for each mixing batch for later determination of chemical concentration.

[illegible] compare [illegible] the variables [illegible]
the ratio of [illegible]
[illegible]iate of this variable or other variables [illegible]
e variation [illegible] of the estimates can [illegible]
[illegible] design [illegible]
[illegible] or between [illegible] and [illegible]
[illegible] In this example [illegible]
[illegible] units by [illegible] one-way ANOVA with [illegible]
unit s) and interactions [illegible] studies
b[illegible] ing different intervals [illegible]
each statistic [illegible] used to [illegible]

[illegible] APPENDIX [illegible]

1. [illegible]
concerned [illegible] which [illegible]
useful in [illegible]
where one of [illegible] should be [illegible] considered

2. [illegible] qualitative [illegible]

[illegible] It [illegible] relation [illegible]
[illegible] specific [illegible]
[illegible]
[illegible] one measure of [illegible]

[illegible]
[illegible]
[illegible] for [illegible]
[illegible] policy [illegible]
[illegible]
[illegible]

## FURTHER CONSIDERATION

If desired, Forest Service personnel are available to review study plans prior to conduct of the field tests. To insure a timely and helpful review these study plans should be submitted to Director, WO-FPM, at least 45 days before test implementation.

## DEFINITIONS

Analysis of Variance (ANOVA)- A statistical technique used to assess how several independent variables (ie. treatment groups) affect the mean(s) of the dependent variable (ie. insect population, defolation). ANOVA is usually concerned with comparisons involving several (> 2) population means.

Control (Checks) - A series of experimental units (ie. plots) receiving either the standard treatment or no treatment, but included in the experiment under the same conditions as the treatment of interest (ie. insecticide) and not systematically different from them.

Experimental-Use Permit - A permit issued by the Environmental Protection Agency of a State to allow experimentation with an unregistered pesticide or to allow a new use of a registered pesticide. The permit is issued upon determination that the applicant needs such a permit to gather information necessary to register the pesticide for a new use (40 CFR 172, Experimental-Use Permits).

Field Test - A research project considering several insecticide treatment variables under a variety of field conditions.

Operational Project - A full scale control project designed to utilize the best treatment materials, equipment, techniques and strategies available to treat a problem (in this instance, a forest defoliator infestation).

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) and substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A special project that considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy under simulated operational conditions.

Randomization - The assignment of treatments to experimental units so that all units have an equal chance of receiving a treatment

Registration - The process whereby the Environmental Protection Agency and States regulate the use of pesticides under authority of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

Replication - The randomized treatments (including controls) are repeated on 2 or more experimental units. Its function is to provide an estimate of

experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects.

Experimental Units - Area (plots) or objects (trees or leaves) that a single treatment is applied to and from which samples are drawn. The complete collection of these experiment units is the population to which inferences are made.

## SELECTED REFERENCES

1. Williams, C.B. Jr., D.A. Sharpnack, L. Maxwell, P.J. Shea, and M. D. McGregor. 1985. Guide to testing insecticides on coniferous forest defoliators. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station. Gen. Tech. Rept. PSW-85. 38pp.

2. Hurlbert, S.H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs. 54(2):187-211. (esp p199-204).

3. Little, T.M. and F.J. Hills. 1978. Agricultural Experimentation. Design and Analysis. J. Wiley and Sons. 350pp. (esp.p5-11)

4. Milliken, G.A. and D.E. Johnson. 1984. Analysis of Messy Data. Chap.4. Basics of Experimental Design. Lifetime Learning Publ. NY,NY. 398p. (esp. p47-50).

FD-8/8/89
PJS